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High Resolution Emission Spectroscopy of the A $^1\Pi$ – X $^1\Sigma^+$ Fourth Positive Band System of CO from Electron Impact

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We report electron-impact induced fluorescence spectra [300 mÅ full width at half maximum (FWHM)] of CO for 20 and 100 eV impact energies of the spectral region of 1300 to 2050 Å and high resolution spectra (FWHM) of the v′=5 to v″=1 and the v′=3 to v″=0 bands showing that the rotational structure of the band system are modeled accurately. The excitation function of the (0,1) band (1597 Å) was measured from electron impact in the energy range from threshold to 750 eV and placed on an absolute scale from modern calibration standards.

Medium resolution fluorescence spectra [~300 mÅ full width at half maximum (FWHM)] of CO produced by electron impact energy of 100 eV over the spectral region of 1300 to 2050 Å were obtained using an Acton 3.0 meter spectrometer. The features in the far ultraviolet (FUV) emission spectra correspond to the Fourth Positive Band System (A $^1\Pi$ – X $^1\Sigma^+$) of CO, atomic multiplets from C and O along with their ions.. The obtained spectra, along with one taken at 20 eV impact energy, allowed for the direct calculation of the electron impact cross sections and the calculation of the absolute electron transition as a function of internuclear distance. High resolution of the (3,0) band and emission cross section from threshold to 750 eV of the (0,1) band were also obtained.

The recalculation of the electron impact cross sections at both 100 and 20 eV were tabulated. These cross sections are an improvement for the CO 4th positive bands when compared to the previous works of Aarts and de Heer (1970), Mumma et al. (1971) and Ajello (1971). The cross section value at 100 eV for the entire 4th positive band system as reported by Ajello (1971) was ~31 x 10^{-18} cm^2, which is lower by 9% then the 34.4 x 10^{-18} cm^2 value obtained from experimental spectra.

We built a model that explains the high resolution rotational fine structure of the (3,0). The spectra in Figure 1 shows this model in comparison with the experimental obtained spectra for the (3,0) band. There is evidence of small self-absorption of the (3,0) and at high values of Q.

The energy dependence of the CO A $^1\Pi$ cross section was studied by measuring the excitation function of the strong A $^1\Pi$ (v′=0) - X $^1\Sigma^+$ (v″=1) band at 1597 Å in the electron impact energy range from threshold to 750 eV. Relative excitation function data were put on an absolute scale by normalizing the intensity at 100 eV to an emission cross section value of 1.12 x 10^{-18} (Beegle et al. 1999).

There is a cascade from the higher lying B and C states to the A state and it was found to be a significant percentage of the total excitation cross section, varying from 9% for the v′ = 0 to 4% for the v″ = 6 at 100 eV.

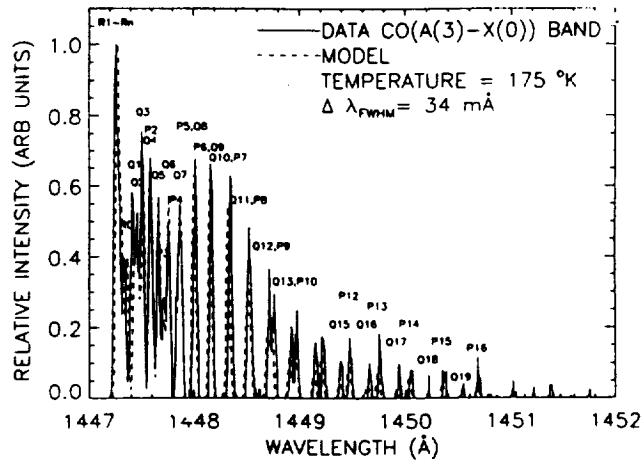

Fig. 1 High resolution spectrum of the CO (A-X) (3,0) band data (solid) and model (dash) normalized to unity at the R-branch head in the wavelength range of 1447 to 1452 Å. The FWHM is 34 mÅ.

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REFERENCES

Aarts J. F. M., and de Heer F. J., 1970, *J Chem Phys* **52** 3554

Ajello J. M., 1971, *J Chem Phys* **55**, 3158

Beegle et al. 1999 submitted to A & A

Mumma M. J., Stone E. J. and Zipf E. C., 1971, *J Chem Phys* **54**, 2627